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A56.9
R31
ARS-41-135

8404

A COMPUTER MAPPING METHOD FOR ANALYSIS AND SUMMARY OF RAINFALL DATA

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AUGUST 1967 **ARS 41-135**

Agricultural Research Service

UNITED STATES DEPARTMENT OF AGRICULTURE

Southern Plains Branch
Soil and Water Conservation Research Division
Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE
Chickasha, Okla.

A COMPUTER MAPPING METHOD FOR ANALYSIS AND SUMMARY OF RAINFALL DATA[1]

Arlin D. Nicks [2]

INTRODUCTION

The electronic computer and high-speed printer are being used by the Southern Plains Watershed Research Center at Chickasha, Okla., to map rainfall data directly on computer printout sheets. This technique has proved to be practical, useful, and money saving, so it is described for the benefit of others who might have problems similar to those encountered at Chickasha.

The data from 222 rain gages in the project network are being processed by electronic computer. Cards are accumulating at a rate of 50,000 per year. The processing of these cards yields tabulations of storm rainfall amounts, time increment amounts or intensities, and various correlation coefficients for each rain gage. These tabulations need to be portrayed so the data can be readily visualized and interpreted. The most convenient portrayal is a map showing the distribution of rainfall or rainfall characteristics over the watershed. However, manual plotting of the information on watershed maps is time consuming and laborious. This manual operation was eliminated by programming the computer and high-speed printer to print the rainfall data at their proper relative locations in space. A transparent overlay showing watershed boundaries properly positioned on the printout sheet produces an instant map.

The ease with which the maps are produced has made it practical to map all rainfall events over the 1,130-square-mile watershed and the 17 subdrainage areas within it. Chronologically bound daily maps provide a catalogued summary of the rainfall, which the project staff can use as a ready reference.

PROCEDURE

Rain gage location maps of the entire study reach and the gaged tributary watersheds were reduced in size to conform to the margins of a standard 10 1/2- by 15-inch data-processing form. A 10- by 12-inch sheet of graph paper was laid on each of these maps so that margins and gage locations could be traced. From these traces Fortran format statements were written for lines that contained gage locations, and printer carriage control statements were written for lines without gage locations. This procedure defined the gage locations from the watershed maps in terms of a computer language. When appropriate print statements and other control information were added, a Fortran computer program resulted that would print the rainfall data at the rain gage locations.

An example of the computer output resulting from the daily rainfall map program is shown in figure 1. Daily rainfall has been plotted for 168 values in this illustration. Because of computer limitation, this number is the maximum that can be plotted; however, these gages give the general distribution over the area. The decimal points represent the gage locations within ± 0.05 inch horizontally and ± .08 inch vertically of the actual gage location shown on the original watershed maps. All gage values were listed following each map, so that the gage amounts not shown could be plotted manually, if needed.

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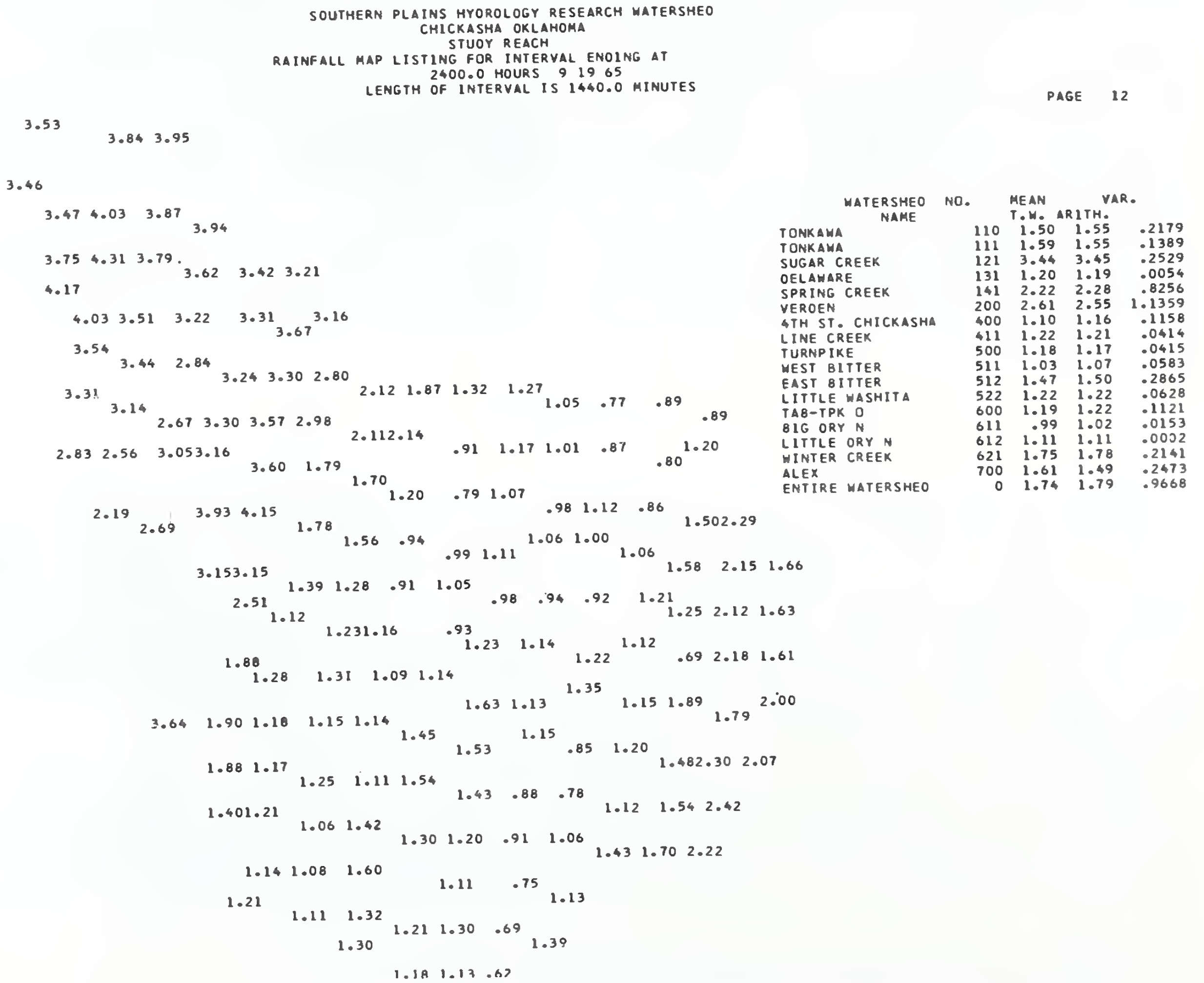
[1] Soil and Water Conservation Research Division, Agricultural Research Service, U.S. Department of Agriculture, in cooperation with the Oklahoma Agricultural Experiment Station.

[2] Agricultural engineer.

The data were summarized further by printing the average rainfall for the subdrainage areas on daily maps. Figure 2 shows an example of the output of this program. The printout sheet was rerun through the computer, and the average value table was printed on the map, as shown in the upper right corner of figure 2. A clear plastic overlay of the watershed boundary can be laid over the map to facilitate interpretation of the data. Isohyetal patterns can be drawn on the maps, adjusted to actual gage location as depicted on the overlay and areas determined with sufficient accuracy by planimetering.

Figures 3 and 4 show examples of the mapping program method applied to storm rainfall patterns from clock intensity data on Sugar Creek Watershed (203 square miles). The plotted values are average intensities registered at the gage locations for the interval shown in the map heading. The length of interval can be chosen to fit the need of analysis and consecutive time intervals printed throughout a storm, thus providing an aid to the study of time and spatial distribution of cells of rainfall.

Once the format is written for a particular watershed it can also be used to display other data. Figure 5 shows an example of the Little Washita watershed where inter-station correlation coefficients were computed and the map program used to present the results.

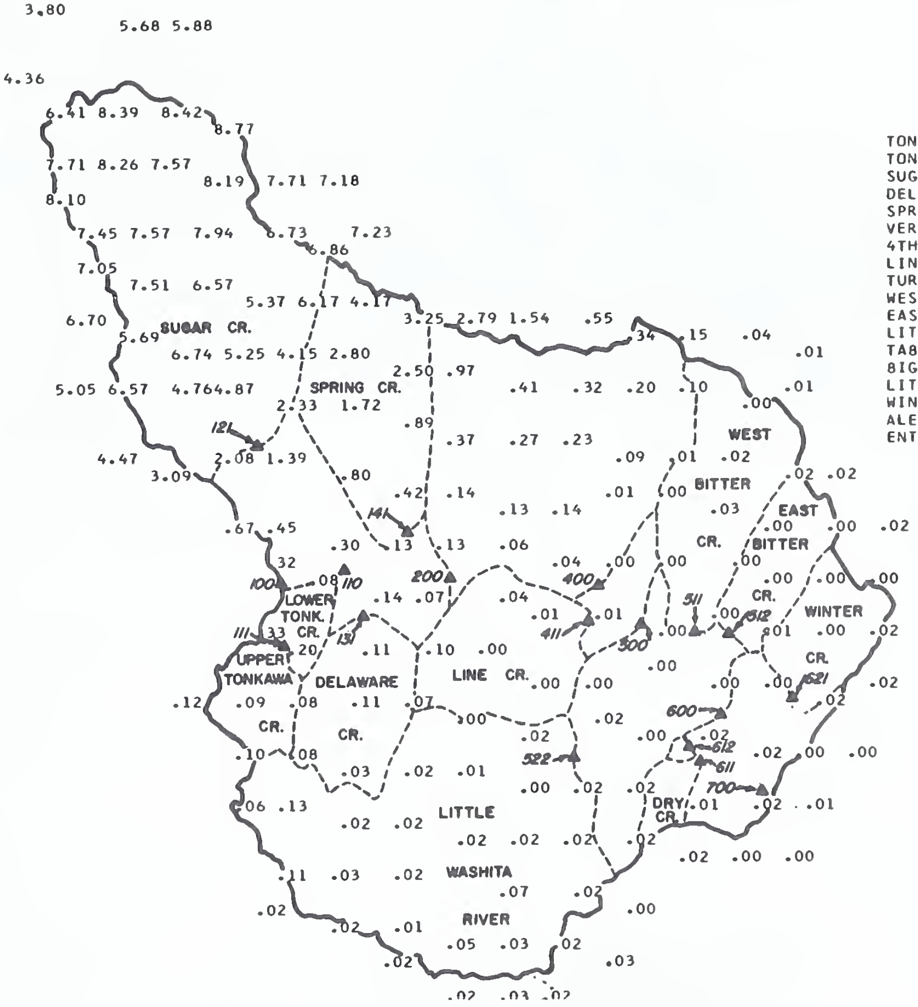


```
                                  SOUTHERN PLAINS HYOROLOGY RESEARCH WATERSHEO
                                              CHICKASHA OKLAHOMA
                                                 STUOY REACH
                              RAINFALL MAP LISTING FOR INTERVAL ENOING AT
                                               2400.0 HOURS  9 19 65
                                        LENGTH OF INTERVAL IS 1440.0 MINUTES
                                                                                                                  PAGE   12

   3.53
            3.84 3.95

 3.46
     3.47 4.03  3.87
                     3.94
     3.75 4.31 3.79 .
                    3.62  3.42 3.21
     4.17
        4.03 3.51  3.22   3.31    3.16
                              3.67
        3.54
             3.44  2.84
                        3.24 3.30 2.80
                                       2.12 1.87 1.32  1.27
       3.31
                                                            1.05  .77   .89
            3.14
                                                                            .89
                 2.67 3.30 3.57 2.98
                                      2.112.14
                                                 .91  1.17 1.01  .87     1.20
      2.83 2.56  3.053.16
                                                                       .80
                           3.60  1.79
                                      1.70
                                          1.20   .79 1.07
                                                            .98 1.12  .86
          2.19       3.93 4.15
                                                                          1.502.29
               2.69             1.78
                                     1.56  .94           1.06 1.00
                                                .99 1.11           1.06
                                                                        1.58  2.15 1.66
                     3.153.15
                               1.39 1.28  .91  1.05
                                                     .98  .94  .92    1.21
                         2.51
                                                                        1.25 2.12 1.63
                             1.12
                                   1.231.16     .93
                                                  1.23  1.14       1.12
                                                              1.22       .69 2.18 1.61
                        1.88
                           1.28  1.31  1.09 1.14
                                                              1.35
                                                  1.63 1.13        1.15 1.89      2.00
                                                                              1.79
                3.64  1.90 1.18  1.15 1.14
                                           1.45         1.15
                                                 1.53         .85  1.20
                                                                       1.482.30 2.07
                      1.88 1.17
                                1.25  1.11 1.54
                                                 1.43  .88  .78
                                                                  1.12  1.54 2.42
                      1.401.21
                                1.06 1.42
                                           1.30 1.20  .91  1.06
                                                                 1.43 1.70 2.22
                           1.14 1.08  1.60
                                                1.11    .75
                                                            1.13
                         1.21
                                1.11  1.32
                                           1.21 1.30  .69
                                                          1.39
                                     1.30

                                           1.18 1.13 .62
```

```
        WATERSHEO  NO.     MEAN       VAR.
           NAME           T.W. ARITH.
TONKAWA                110  1.50  1.55   .2179
TONKAWA                111  1.59  1.55   .1389
SUGAR CREEK            121  3.44  3.45   .2529
OELAWARE               131  1.20  1.19   .0054
SPRING CREEK           141  2.22  2.28   .8256
VEROEN                 200  2.61  2.55  1.1359
4TH ST. CHICKASHA      400  1.10  1.16   .1158
LINE CREEK             411  1.22  1.21   .0414
TURNPIKE               500  1.18  1.17   .0415
WEST BITTER            511  1.03  1.07   .0583
EAST BITTER            512  1.47  1.50   .2865
LITTLE WASHITA         522  1.22  1.22   .0628
TAB-TPK O              600  1.19  1.22   .1121
BIG ORY N              611   .99  1.02   .0153
LITTLE ORY N           612  1.11  1.11   .0002
WINTER CREEK           621  1.75  1.78   .2141
ALEX                   700  1.61  1.49   .2473
ENTIRE WATERSHEO         0  1.74  1.79   .9668
```

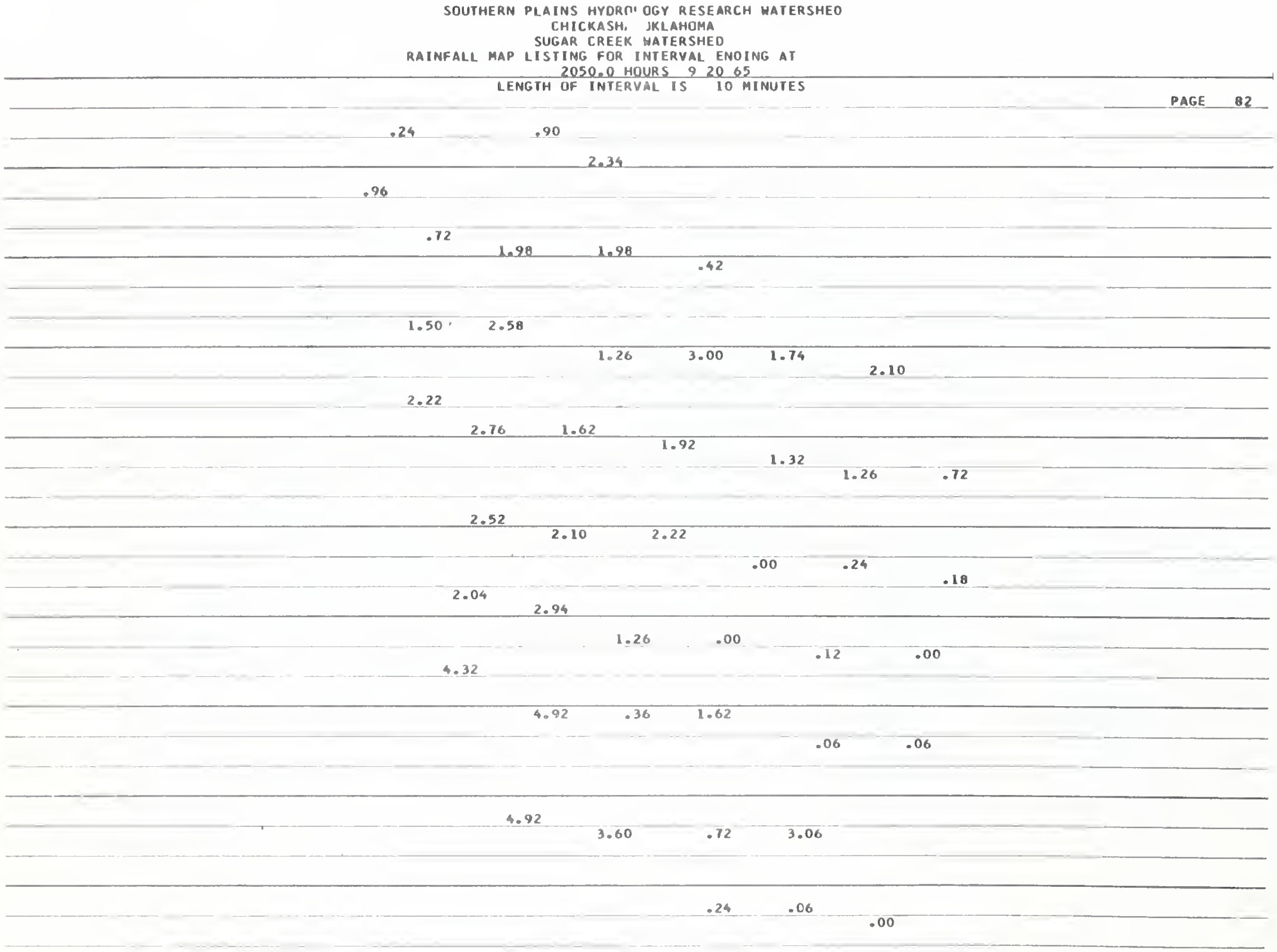
Figure 1.--Computer output of printed map shows daily rainfall amounts at 168 rain gages of the 1,200-square-mile Washita network.

```
                    SOUTHERN PLAINS HYOROLOGY RESEARCH WATERSHEO
                                CHICKASHA OKLAHOMA
                                   STUOY REACH
                    RAINFALL MAP LISTING FOR INTERVAL ENOING AT
                             2400.0 HOURS   9 20 65
                         LENGTH OF INTERVAL IS 1440.0 MINUTES
                                                                        PAGE   14
```



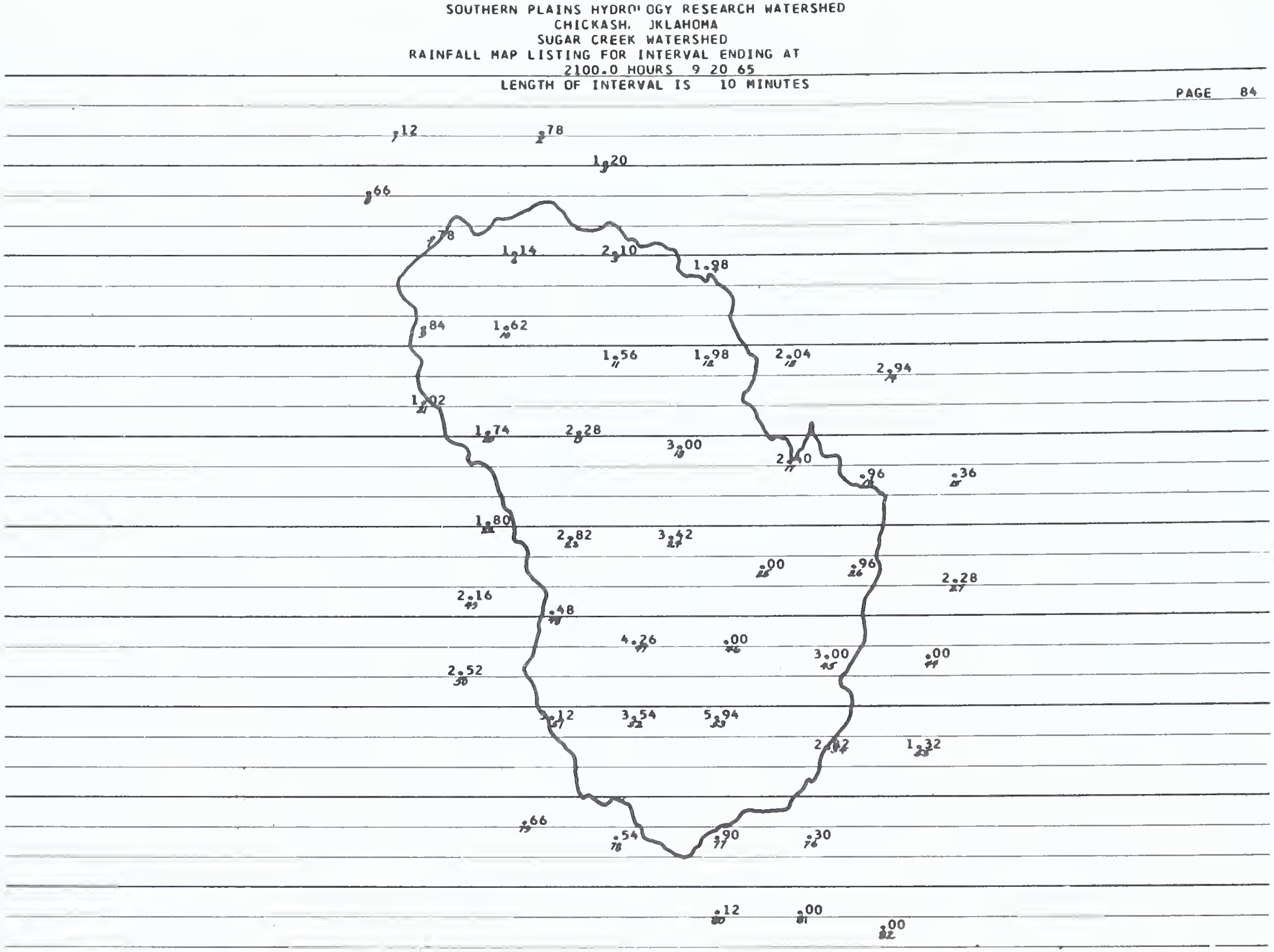
```
      WATERSHEO  NO.     MEAN        VAR.
        NAME           T.W. ARITH.
TONKAWA                110    .14    .15    .0096
TONKAWA                111    .12    .15    .0102
SUGAR CREEK            121   6.47   6.25   3.9473
DELAWARE               131    .09    .09    .0027
SPRING CREEK           141   2.20   2.51   5.5774
VEROEN                 200   3.54   3.47  10.4499
4TH ST. CHICKASHA      400    .30    .41    .5638
LINE CREEK             411    .03    .03    .0016
TURNPIKE               500    .02    .03    .0014
WEST BITTER            511    .02    .03    .0019
EAST BITTER            512   /.00    .01    .0001
LITTLE WASHITA         522    .03    .03    .0010
TAB-TPK O              600    .02    .03    .0011
BIG DRY N              611    .02    .01    .0001
LITTLE ORY N           612    .00    .00    .0000
WINTER CREEK           621    .01    .01    .0001
ALEX                   700    .01    .01    .0001
ENTIRE WATERSHEO         0   1.39   1.51   7.1847
```

Figure 2.--Map printout overlain with clear plastic outline of watershed boundaries.



```
           SOUTHERN PLAINS HYDRO' OGY RESEARCH WATERSHEO
                       CHICKASH, JKLAHOMA
                      SUGAR CREEK WATERSHED
       RAINFALL MAP LISTING FOR INTERVAL ENOING AT
                        2050.0 HOURS  9 20 65
                 LENGTH OF INTERVAL IS   10 MINUTES
                                                                                             PAGE    82
     .24             .90

                            2.34

  .96


         .72
                 1.98        1.98
                                        .42



       1.50'    2.58

                             1.26      3.00     1.74
                                                           2.10

       2.22

              2.76       1.62
                                    1.92
                                                1.32
                                                        1.26       .72


              2.52
                        2.10       2.22

                                              .00       .24
                                                                   .18
            2.04
                     2.94

                               1.26       .00
                                                     .12        .00
           4.32


                     4.92       .36     1.62

                                                     .06       .06




                  4.92
                             3.60        .72      3.06




                                         .24      .06
                                                           .00
```

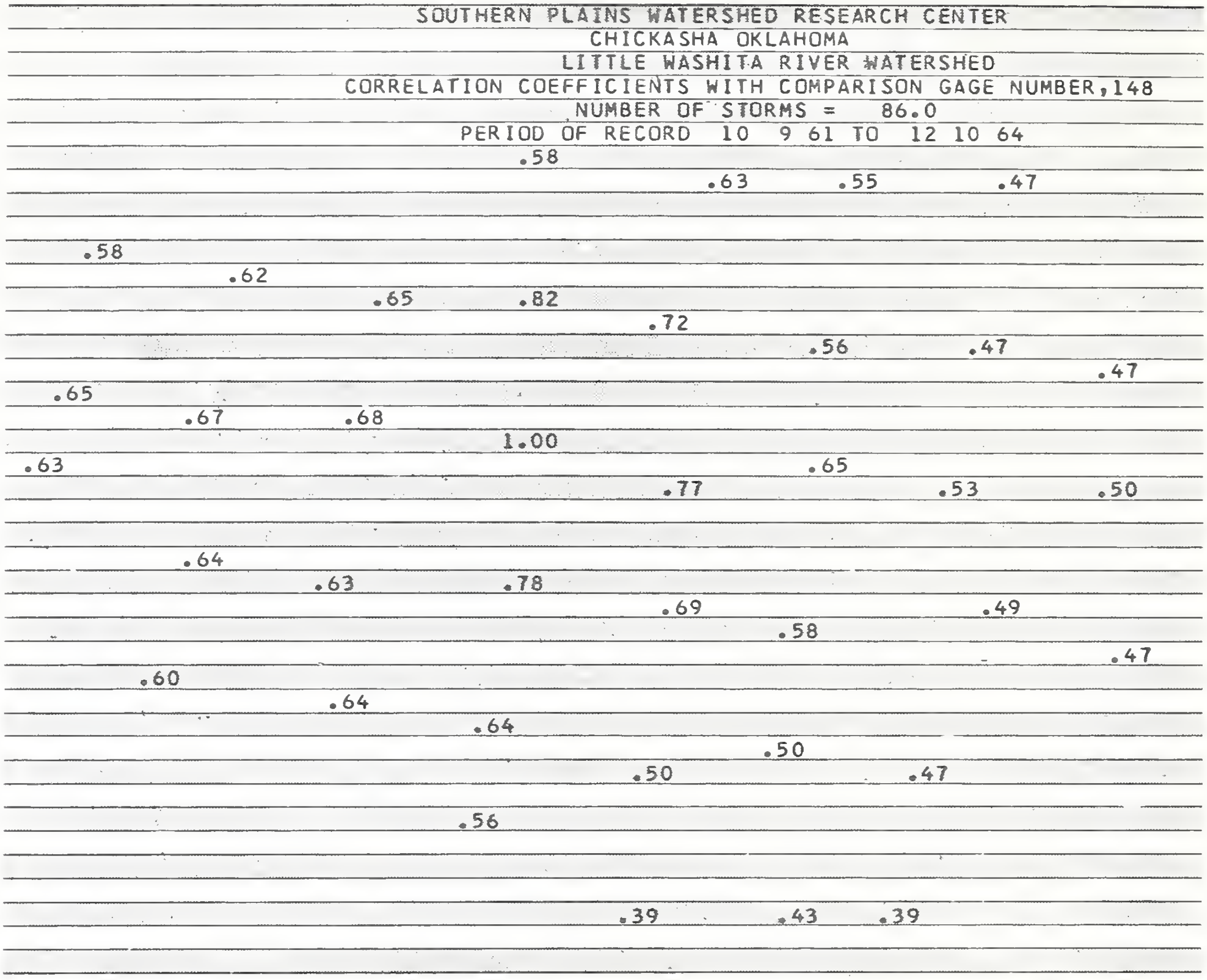
Figure 3.--Computer printout of 10-minute clock interval of rainfall intensity on Sugar Creek Watershed.



SOUTHERN PLAINS HYDROLOGY RESEARCH WATERSHED
CHICKASHA, OKLAHOMA
SUGAR CREEK WATERSHED
RAINFALL MAP LISTING FOR INTERVAL ENDING AT
2100.0 HOURS 9 20 65
LENGTH OF INTERVAL IS 10 MINUTES

PAGE 84

Figure 4.--An example of a tributary watershed map with watershed boundary and gage number overlay. Values shown are intensities at 10-minute clock intervals.



```
                           SOUTHERN PLAINS WATERSHED RESEARCH CENTER
                                       CHICKASHA OKLAHOMA
                                     LITTLE WASHITA RIVER WATERSHED
                      CORRELATION COEFFICIENTS WITH COMPARISON GAGE NUMBER,148
                                      NUMBER OF STORMS =    86.0
                              PERIOD OF RECORD  10   9 61  TO   12 10 64
                                  .58
                                               .63      .55        .47


    .58
              .62
                        .65       .82
                                           .72
                                                      .56        .47
                                                                          .47
  .65
           .67        .68
                                 1.00
.63                                                   .65
                                            .77                .53        .50


           .64
                    .63          .78
                                            .69                   .49
                                                    .58
                                                                           .47
        .60
                     .64
                               .64
                                                   .50
                                          .50                .47

                              .56



                                         .39      .43    .39
```

Figure 5.--An example of the map program used as a subroutine of a larger program. Inter-station correlation coefficients were computed and the final results were displayed in a map form.

CONCLUSIONS

Computer mapping has proved to be an economical and timesaving technique in the processing, summarization, and analysis of rainfall data. The processing of 5 years of daily rainfall by this method has shown the cost per map to be about 5 cents, with this cost being dependent on machine size, speed, and rental rate. Where machine data processing systems are now being used, this method could be readily adopted. Its major advantage is to give the data user an opportunity to make meaningful summaries of large volumes of data with computer equipment.